

CLAIMS

What is claimed is:

1. A method for increasing the degree of isomerization of a diesel product comprising:
 - (a) reacting a mixture of hydrogen and carbon monoxide at conversion promoting conditions to form a synthetic hydrocarbon stream, wherein the synthetic hydrocarbon stream comprises primarily C₅₊ paraffins;
 - (b) forming a fractionator feedstream comprising the synthetic hydrocarbon stream;
 - (c) separating the fractionator feedstream into at least three fractions including:
 - (i) a light fraction;
 - (ii) an intermediate fraction; and
 - (iii) a heavy fraction;wherein the light fraction has a boiling range with a 5% boiling point of about 300°F, wherein the intermediate fraction has a boiling range with a 5% boiling point lower than that of the heavy fraction, and higher than that of the light fraction;
 - (d) passing at least a portion of the heavy fraction to a first hydroconversion zone containing a hydrocracking catalyst;
 - (e) reacting at least a portion of the heavy fraction from step (d) with hydrogen under hydrocracking promoting conditions in the first hydroconversion zone to form a first hydroconverted effluent;
 - (f) passing at least a portion of the first hydroconverted effluent to a second hydroconversion zone;
 - (g) passing at least a portion of the intermediate fraction to the second hydroconversion zone; and
 - (h) reacting at least a portion of the first hydroconverted effluent and at least a portion of the intermediate fraction with hydrogen in the second hydroconversion zone with a catalyst under conditions suitable to promote hydroisomerization, hydrocracking, dewaxing, or combinations thereof, to form a second hydroconverted effluent, wherein the portion of the intermediate fraction passed to the second hydroconversion zone and the portion of the first hydroconverted effluent passed to the second hydroconversion zone have lost their separate

identities.

2. The method of claim 1 further comprising
 - (i) separating the second hydroconverted effluent produced in step (h) to create at least a middle distillate fraction therefrom.
3. The method of claim 2 further comprising forming a synthetic paraffinic fuel by blending
 - (1) at least a portion of the light fraction from step (b);
 - (2) at least a portion of the middle distillate fraction from step (i); and
 - (3) optionally, a portion of the intermediate fraction from step (b) not passed to second hydroconversion zone.
4. The method of claim 2 wherein the fractionation of steps (c) and (i) are carried out in the same fractionator.
5. The method of claim 2 wherein the fractionation of steps (c) and (i) are carried out in different fractionators.
6. The method of claim 1 wherein the hydrocarbon synthesis in step (a) comprises a Fischer-Tropsch synthesis.
7. The method of claim 1 wherein the fractionator feedstream of step (b) further comprises hydrocarbons derived from refining of a crude oil, shale oil, or tar sand source.
8. The method of claim 1 wherein the synthetic hydrocarbon stream is hydrotreated under “ultra-low severity” hydrotreating conditions before forming step (b).
9. The method of claim 1 wherein the synthetic hydrocarbon stream is hydrotreated under mild hydrotreating conditions.
10. The method of claim 1 wherein the second hydroconversion zone is located downstream of

the first hydrocracking zone.

11. The method of claim 10 wherein the second hydroconversion zone comprises a dewaxing catalyst.

12. The method of claim 1 wherein the second hydroconversion zone comprises hydroisomerization promoting conditions.

13. The method of claim 1 wherein at least one of the first and the second hydroconversion zones comprises a catalyst gradient, and further wherein the catalyst gradient has an acidity gradually decreasing along said hydroconversion zone.

14. The method of claim 1 wherein the catalysts in the first and second hydroconversion zones have the same hydrogenation component.

15. The method of claim 1 wherein the catalysts in the first and second hydroconversion zone comprise different hydrogenation components.

16. The method of claim 1 wherein the catalysts in the first and second hydroconversion zones comprise different cracking components.

17. The method of claim 1 wherein the catalyst in the second hydroconversion zone has a lower acidity than the catalyst in the first hydroconversion zone.

18. The method of claim 1 wherein the first and second hydroconversion zones are contained within a single vessel.

19. The method of claim 1 wherein the first and second hydroconversion zones are part of a continuous catalyst bed.

20. The method of claim 1 wherein the first and second hydroconversion zones are in separate vessels.

21. The method of claim 1 wherein the heavy fraction comprises a boiling range with a 5% point T_H equal to or greater than about 640°F.
22. The method of claim 21 wherein the intermediate fraction comprises a boiling range with a 5% boiling point T_I and a 95% boiling point T_J , wherein T_J is between about $T_H - 100^\circ\text{F}$ and $T_H + 150^\circ\text{F}$, and wherein T_I is between about 500°F and $T_J - 50^\circ\text{F}$.
23. The method of claim 21 wherein the light fraction comprises a boiling range with a 5% boiling point between about 330°F and about 350°F and a 95% boiling point T_k , wherein T_k is between about $T_I - 50^\circ\text{F}$ and $T_I + 50^\circ\text{F}$, if T_I is less than 640°F, or T_k is about equal to about 640°F if T_I is greater than about 640°F.
24. The method of claim 1 wherein the heavy fraction comprises hydrocarbons with 20 or more carbon atoms.
25. The method of claim 24 wherein the intermediate fraction comprises hydrocarbons having between about 15 and about 20 carbon atoms.
26. The method of claim 1 wherein the heavy fraction comprises hydrocarbons with 'n' or more carbon atoms, and the intermediate fraction comprises hydrocarbons having more than about 15 carbon atoms, but less than about 'n' carbon atoms, wherein 'n' is greater than 20.
27. The method of claim 1 wherein the second hydroconversion zone has an inlet temperature equal to or greater than that of the first hydroconverted effluent.

28. A method for increasing the degree of isomerization of a diesel product, derived from synthesis gas, comprising:

- (a) providing a first fraction comprising C₂₀₊ liquid hydrocarbons, wherein said first fraction has a 5% boiling point equal to or greater than about 640°F;
- (b) providing a second fraction comprising C₁₅-C₂₀ liquid hydrocarbons,
- (c) wherein said second fraction has a 5% boiling point between about 400°F and about 550°F, and a 95% boiling point equal to or less than about 640°F, and
- (d) wherein the first and second fractions comprise primarily paraffins synthesized from synthesis gas;
- (e) reacting at least a portion of the first fraction in a first hydroconversion zone to generate a first hydroconverted hydrocarbon product stream;
- (f) reacting at least a portion of the second fraction in a second hydroconversion zone to generate a second hydroconverted hydrocarbon product stream;
- (g) wherein at least a portion of the first hydroconverted hydrocarbon product stream is optionally fed to the second hydroconversion zone.

29. The method according to claim 28 further comprising fractionating at least a portion of the second hydroconverted hydrocarbon product stream to produce at least a middle distillate with a 5% boiling point between about 330°F and about 350°F, and a 95% boiling point between about 500°F and about 600°F.

30. The method according to claim 29 further comprising providing a third fraction, wherein the third fraction has a 5% boiling point between about 330°F and about 350°F, and a 95% boiling point between about 400°F and about 550°F and forming a synthetic paraffinic diesel by blending

- (1) at least a portion of the third fraction; and
- (2) at least a portion of the middle distillate.

31. The method according to claim 30 wherein the synthetic paraffinic diesel blend further comprises at least a portion of the first hydroconverted hydrocarbon product stream, wherein said fraction of the first hydroconverted hydrocarbon product has a 5% boiling point between about 330°F and about 350°F, and a 95% boiling point between about 500°F and about 600°F.

32. The method according to claim 30 wherein the synthetic paraffinic diesel blend further comprises at least a portion of the second fraction not passed to the second hydroconversion zone.
33. The method according to claim 31 wherein the synthetic paraffinic diesel blend further comprises at least a portion of the second fraction not passed to the second hydroconversion zone.
34. The method according to claim 30 wherein the first and second fractions are hydrotreated prior to reaction in their respective hydroconversion zone.
35. The method according to claim 30 further comprising passing at least a portion of said first hydroconverted hydrocarbon product stream to the second hydroconversion zone;
36. The method of claim 35 wherein the second hydroconversion zone has an inlet temperature equal to or greater than that of the first hydroconverted hydrocarbon product stream.
37. A method for increasing the production yield of a diesel product, wherein the diesel product comprises primarily products derived from a hydrocarbon synthesis, said method comprises:
- (a) providing a hydrocarbon stream comprising C_{5+} paraffins, wherein a majority of said C_{5+} paraffins are products of a hydrocarbon synthesis from synthesis gas;
 - (b) separating by fractionation said hydrocarbon stream into at least
 - (i) a wax fraction comprising a boiling range with a 5% boiling point T_H , wherein T_H is equal to or greater than about 640°F;
 - (ii) an intermediate fraction comprising a boiling range with a 5% boiling point T_I and a 95% boiling point T_J , wherein T_J is between about $T_H - 100^\circ\text{F}$ and $T_H + 150^\circ\text{F}$, and wherein T_I is between about 500°F and $T_J - 50^\circ\text{F}$; and;
 - (iii) a middle distillate fraction comprising a boiling range with a 5% boiling point between about 330°F and about 350°F, and a 95% boiling point T_K , wherein T_K is between about $T_I - 50^\circ\text{F}$ and $T_I + 50^\circ\text{F}$, if T_I is less than about 640°F, or T_K is equal to about 640°F if T_I is greater than 640°F;

- (c) passing at least a portion of the wax fraction in a first hydroconversion zone under hydrocracking promoting conditions to convert with hydrogen at least a portion of the wax fraction to form a first hydroconverted effluent;
 - (d) reacting in the presence of hydrogen the first hydroconverted effluent and at least a portion of intermediate fraction in a second hydroconversion reaction zone under suitable hydroconversion conditions to promote hydroisomerization, hydrocracking, dewaxing, or any combination thereof, to form a second hydroconverted effluent; and
 - (e) feeding said second hydroconverted effluent to the fractionator of step (b),
 - (f) forming a diesel product, wherein said diesel product comprises at least a portion of the resulting middle distillate fraction and optionally a portion of the intermediate fraction if T_J is less than about 640°F.
38. The method of claim 37 wherein T_H is about equal to about 640°F; T_J is about equal to about 640°F; T_I is between about 400°F and about 600°F; and T_K is equal to about T_I .
39. The method of claim 37 wherein T_H is about equal to about 640°F; T_J is between about 550°F and about 800°F; T_I is between about 400°F and about $T_J-50^\circ\text{F}$; and T_K is equal to about T_I .
40. The method of claim 37 wherein T_H is equal to about 800°F; T_J is between about 700°F and about 850°F; T_I is between about 640°F and about $T_J-50^\circ\text{F}$; and T_K is equal to about 640°F.
41. The method of claim 37 wherein T_H is about equal to about 900°F; T_J is between about 700°F and about 900°F; T_I is between about 640°F and about $T_J-50^\circ\text{F}$; and T_K is equal to about 640°F.
42. The method of claim 37 further comprising passing the hydrocarbon stream in a hydrotreater under hydrotreating promoting conditions before step (b).